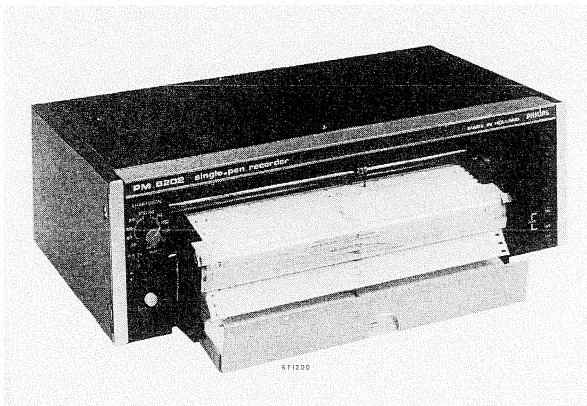
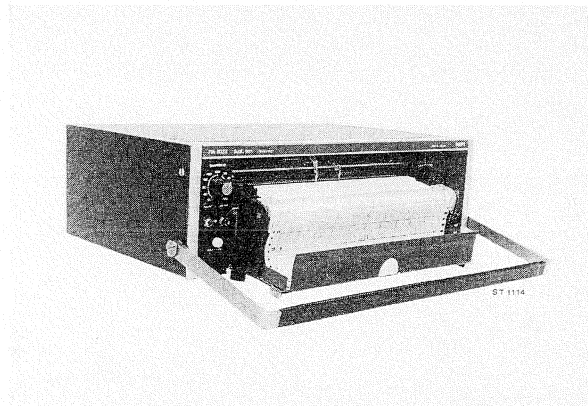
Compact Chart Recorder
Single-line PM8202/01-/21-/32
Double-line PM8222/01-/21-/32

Operating manual

9499 430 05701
800630/1





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IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leisungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparations)

Dans votre correspondance et dans vos reclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

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ADDENDUM TO THE OPERATING MANUAL FOR THE PM 8202 - PM 8222 - PM 8203A

This manual can also be used for the following versions:

PM 8202 - PM 8222/02, /03, /22, /23, /33, /34.
PM 8203A/03, together with the PM 8203A Operating Manual.

IMPORTANT: the rated value of the fuse for the PM 8202/03, /23, /34 and the PM 8203A/03 must be:

mains voltage	fuse (DIN 41571, IEC 127)
220 or 245 V	200 mA-T-250 V (slow blow)
110 or 127 V	400 mA-T-250 V (slow blow)

ERGÄNZUNG ZUR GEBRAUCHSANLEITUNG DES PM 8202 - PM 8222 - PM 8203A

Diese Gebrauchsanleitung kann auch für die folgenden Ausführungen benutzt werden:

PM 8202 - PM 8222/02, /03, /22, /23, /33, /34.
PM 8203A/03, zusammen mit der Gebrauchsanleitung für den PM 8203A.

WICHTIG: der Wert der Sicherung für den PM 8202/03, /23, /34 und den PM 8203A/03 muss sein:

Netzspannung	Sicherung (DIN 41571, IEC 127)
220 oder 245 V	200 mA-T-250 V (träge)
110 oder 127 V	400 mA-T-250 V (träge)

SUPPLEMENT A LA NOTICE D'EMPLOI DU PM 8202 - PM 8222 - PM 8203A

La présente notice d'emploi est aussi valable pour les versions suivantes:

PM 8202 - PM 8222/02, /03, /22, /23, /33, /34.
PM 8203A/03, avec la notice d'emploi du PM 8203A.

IMPORTANT: le calibre des fusibles pour les versions PM 8202/03, /23, /34 et le PM 8203A/03 doit être:

Tension secteur	Fusible (DIN 41571, IEC 127)
220 ou 245 V	200 mA-T-250 V (temporisé)
110 ou 127 V	400 mA-T-250 V (temporisé)

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0. OPERATOR SAFETY

Read this page carefully before installation and use of the instrument.

0.1 GENERAL INFORMATION

The instrument described in this manual is designed to be used by properly-trained personnel only. Adjustment, maintenance and repair of the exposed equipment shall be carried out only by qualified personnel, who are aware of the hazards involved.

0.2 SAFETY PRECAUTIONS

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally-accepted safety procedures in addition to the safety precautions specified in this manual. Specific warning and caution statements, where they apply, will be found throughout the manual. Where necessary, the warning and caution statements and/or symbols are marked on the apparatus.

0.3 CAUTION AND WARNING STATEMENTS

CAUTION: is used to indicate correct operating or maintenance procedures in order to prevent damage to or destruction of the equipment or other property.

WARNING: calls attention to a potential danger that requires correct procedures or practices in order to prevent personnel injury.

0.4 SYMBOLS

Read the operating instructions.

Protective earth (grounding) terminal (black)

Explanation of symbol
To preserve the instrument from damage the operator must refer to an explanation in the instruction manual.

0.5 IMPAIRED SAFETY PROTECTION

Whenever it is likely that safe operation is impaired, the instrument **must** be made inoperative and secured against any unintended operation.
The appropriate servicing authority must then be informed.

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1. INTRODUCTION

The single and dual pen recorders PM 8202 and PM 8222 have been designed to meet high performance requirements. For this purpose they combine very compact dimensions and low weight with provisions for rack or panel mounting, rear panel inputs and remote control facilities.

The application range of both recorders can be expanded considerably as a result of a great variety of accessories.
The input sensitivity can be adjusted to any desired signal amplitude from 1mV up to 50 V by means of single or multirange units.
Temperatures can also be measured when a temperature linearisation amplifier is fitted.
A high writing speed, with 0.25 sec. for 250 mm full scale deflection provides clean and accurate recording of fast changing signals.
The flat chart table design enables the operator direct access to the recording for taking notes and evaluation.

Both recorders use the convenient and proven Z-fold chart system, which provides easy checking of recording over the entire 20 m chart length plus easy filling.
Chart speeds are adjustable from 0.05 up to 100 cm/min. in 11 calibrated steps.
In order to exploit entirely the possibilities of the instrument and to obtain a better idea of the application, it is recommended to read carefully this operation manual.

2. VERSIONS

The single pen recorder PM 8202/ . . and the dual pen recorder PM 8222/ . . are available in the following versions.

-/01 Recorder with (a) single measuring range unit(s) having a span selected in the range from 10 mV up to 50V (in a 1-2-5 sequence), corresponding to type numbers PM9870/04 to -/15 (fig. 1).

-/21 Recorder with multi-range unit PM 9872/02 making it possible to set a 12 position selector from 10 mV to 50 V in a 1-2-5 sequence. Zero suppression up to −500% is provided (fig. 2a).

-/32 Recorder with multi-range unit PM 9872A/01 making it possible to set a 12 position selector from 1 mV to 5 V. Zero suppression up to −500% is provided (fig. 2b).

The above-mentioned versions may be provided with one or more options as mentioned in chapter 6.

Fig. 3 shows a dual pen recorder PM 8222/32 provided with a temperature linearisation amplifier for one channel (red) and provided with a set point unit for each channel.

3. ACCESSORIES

3.1. SUPPLIED WITH THE INSTRUMENT (Fig. 4)

- Operation Manual
- Mains supply cable
- 1 packet with 5 books of folded chart (0 ... 100 linear)
- Chart collection tray
- Plastic dust cover
- Service box containing:
  2 nylon pen cartridges, red
  2 nylon pen cartridges, blue (for PM 8222 only)
  1 fuse 500 mA (220 V) } for PM 8222
  2 fuses 1 A (110 V) }
  1 fuse 250 mA (220 V) } for PM 8202
  2 fuses 500 mA (110 V) }
  1 bottle with potentiometer contact oil
  2 brushes

3.2. CONSUMABLE SPARES

The typical consumable spares can be ordered under following typenumbers:

- Chart

  Each typenumber covers a packet with 5 fold chart books, each having a length of 20 m.

PM 9920/00	standard chart, scale division from 0 ... 100 linear, time lines 10 mm apart.
PM 9920/01	chart with scale division from 100 to zero linear, time lines 10 mm apart.
PM 9920/03	chart with scale division from 0 ... 100 lines, time lines 2,5 mm apart.
PM 9920/04	chart with scale division from 0 ... 100 lines, time lines 15 mm apart.

- Nylon pen cartridges

  A cartridge has a writing capacity of approx. 1500 m. recording length.

PM 9857/05	10 nylon pen cartridges, red	For PM 8202 or for upper channel in PM 8222
PM 9857B/05	10 nylon pen cartridges, blue	
PM 9856/05	10 nylon pen cartridges, blue	For lower channel in PM 8222
PM 9857/15	10 nylon pen cartridges (red) for event markers PM 9868/05 and PM 9868/10 (writing capacity 80 m)	

4. CONNECTION DATA

4.1. EARTHING

Before any other connection is made, the protective earth terminal ⏚ (at the rear of the recorder) must be connected to a protective conductor. This can be done in one of the following ways:

- The mains plug (of the mains cord supplied with the recorder) may only be inserted into a socket outlet provided with an earth contact. The protective action may not be made ineffective by the use of an extension without protective conductor. Replacing the mains plug is at the users own risk.
- Via a seperate lead connected to the earth terminal ⏚ at the rear of the recorder.

WARNING: **Any interruption of the protective conductor inside or outside the instrument or disconnection of the protective earth terminals is likely to make the instrument dangerous.**
Intentional interruption is prohibited. When an instrument is brought from the cold into a warm environment, condensation may cause a hazardous condition.
Make sure that the earthing requirements are strictly adhered to.

4.2. MAINS SUPPLY (fig. 5)

- Check that the position of the voltage selector corresponds to the local mains voltage.
- Check that the position of the slide switch "50 Hz - 60 Hz" corresponds to the local mains frequency.
- The rated value of the fuse must correspond to the local mains, according to the table below.

Mains voltage	Rated value fuse for PM 8202	Rated value fuse for PM 8222
110 V	500 mA	1 A
127 V	500 mA	1 A
220 V	250 mA	500 mA
245 V	250 mA	500 mA

- Do not connect the recorder to the mains supply until the procedures in chapter 4.3, 5.1, 5.2 and 5.3 have been followed.

NOTES:

- *Disconnect the recorder from the mains before replacing the fuse*
- *The use of repaired fuses and the short-circuiting of fuse holders is prohibited.*

4.3. CONNECTING THE TRANSDUCER (fig. 5 and 6)

NOTE:

For temperature measurements refer to chapter 6.2.8.

Connect the transducer (voltage source) to the input terminals "Hi and Lo" at the rear of the recorder. Preferably use insulated screened cables. The screening of the connection cable is generally connected to the earth terminal ⊥ (also at the rear of the recorder). In some cases the above method of earthing may not be satisfactorily because the influence of interference voltages is still visible (vibrating indication on the recorder) then the correct way of earthing has to be determined empirically, some possibilities are shown in fig. 6.

5. OPERATION

5.1. TRANSPORT SECURITY (fig. 7)

Remove the transport securities by cutting the rubber bands.

5.2. LOADING THE CHART (fig. 7, 8, 9, 10)

- Push down both levers simultaneously and take the chart table out of the recorder.
- Fit the chart collection tray to the chart table by placing the hooks over the pivots.
- Take a fold book and handle as shown in fig. 9.
- Open the cover of the chart supply tray and place the fold book vertically into the supply tray with the round holes at the left hand side.
- Pull the guide rule (at both sides) upwards and slide the chart under the guides and under the guide rule into the collection tray. Ensure that the first two chart perforations are correctly folded in the collection tray. The direction of folding when fed to the collection tray should be same as the folding of the supply book.
- Check that the sprocket pins on the chart drive roller engage the sprocket holes in the chart and that the time division lines are in parallel with the guide rule.
- Push back the guide rule and close the cover on the chart supply tray.
- Raise the writing pens (if they have already been fitted) by means of the pen lift levers and insert the chart table into the recorder; slide if fully home by turning both levers upwards.

NOTE:

When during functioning of the recorder the chart is torn off along the guide rule ensure again that the first two chart perforations are correctly folded in the collection tray, as is mentioned before.

5.3. THE WRITING PENS (fig. 11)

- Insert the pen with red marking into the upper holder and the pen with blue marking into the lower holder.
- Remove the protecting cap from the pen tip.
- Lower the writing pens by the pen lift levers.

NOTE:

When the recorder is not used, fit the protecting caps again, to prevent the nylon pen - cartridges from drying out.

5.4. SWITCHING ON THE RECORDER (fig. 1 and 5)

- Connect the recorder to the mains supply by means of the mains supply cable, supplied with the instrument.
- By depressing push button "POWER" the recorder is switched "ON" and by depressing again it is switched "OFF".

5.5. CHART TRANSPORT (fig. 1)

- Place the speed selector into the desired position (0,05 ... 100 cm/min.) and switch ▼ into position ▼ (forward)
- Always ensure that the first two chart perforations are correctly folded, when starting with a new fold book or when the chart has been torn off (see chapter 5, paragraph 2)

– Placing switch ▲▼ into upper or lower position results in accelerated backward or accelerated forward transport.

NOTE:

The speed increases to 180 cm/min, fast transport overrules normal transport.

5.6. RANGE UNITS

5.6.1. Recorders provided with a single range unit PM 9870M/ . . (fig. 1)

– Adjust the zero point (between + 20% and −120%) to the desired scale point with potentiometer "ZERO-VAR" (screwdriver setting) and with slide switch "ZERO-REC" in position "ZERO" (the transducer is disconnected then and the input of the recorder amplifier is short circuited).

– Place switch "ZERO-REC" to position "REC" so that recording can take place.

– A range unit can be replaced by another unit (with different span) by gripping the outer input terminals at the rear of the recorder and pulling it out. Then insert the required unit.

5.6.2. Recorders provided with a multirange units PM 9872/02 or PM 9872A/01 (fig. 2)

– Range

- Place the selector "RANGE" into the required position. With switch "VAR-CAL" in position "CAL" the scale length corresponds to the selected range.
- With switch "VAR-CAL" in position "VAR" the sensitivity is increased approx. 2.5 times with potentiometer "RANGE" turned fully anti-clockwise (e.g. selector "RANGE" in position 20 mV, the scale length corresponds to a span of approx. 8 mV).

Remark: Switch VAR-CAL is a push button switch in the multirange unit PM 9872/02 and a toggle switch in the unit PM 9872A/01.

– Zero suppression selection

- Adjust the zero to the required point on the scale (see examples here below) by placing switch "ZERO-REC" to position "ZERO" and by turning potentiometer "ZERO SUPPRESSION - VAR". The suppression with the zero adjusted to any point on the scale is to be considered as a negative suppression (e.g. when the indication is positioned at the end of scale a suppression of minus 100% is obtained).
- Now-place switch "ZERO-REC" to position"REC" and place selector "ZERO SUPPRESSION" to the required position, e.g. position 3 stands for plus 300%.
- The total suppression is the sum of both before mentioned values and with switch "ZERO-REC" in position "REC" recording takes place.

Examples:

– A zero suppression of 170% is required.
. Switch in position "ZERO" and adjust the zero to (minus) 30% on the scale with potentiometer "ZERO SUPPRESSION-VAR".
. Switch in position "REC" and place selector to position 2 (+200%). Total suppression 200 − 30 = 170%

– Range 20 mV, required scale beginning 52 mV (scale end is at 72 mV then)
. The required zero-suppression is $\frac{52}{20}$ x 100% = 260%.
. Switch in position "ZERO" and adjust the zero to (minus) 40% on the scale with potentiometer "ZERO SUPPRESSION-VAR".
. Switch in position "REC" and place selector to position 3 (plus 300%). The total suppression is 300 − 40 = 260%.

REMARKS

In position "ZERO" of switch "ZERO REC" the transducer is disconnected and the input of the recorder amplifier is shortcircuited. The position of the "ZERO SUPPRESSION" selector is immaterial. In position "REC" recording can take place.

6. OPTIONS

6.1. REVIEW (fig. 12 and 13)

NOTE:

For completenes the basic components PM 9870M/. . ,
PM 9872/02 and PM 9872A/01 have been mentioned here also.

PM 9860/01	Transparent dust cover.
PM 9861/01	Remote control unit for TTL logic control of "chart transport" and possibility for connecting 2 slave potentiometers.
PM 9862/01	Remote control unit for TTL logic control of "eventmarkers", "pen lift" and "standby-record". Also 2 slave potentiometers may be connected.
PM 9863/01	Remote control unit for TTL logic control of "chart transport" (except of fast transport) and control by contact closure of "event markers" and "pen lift". Also 2 slave potentiometers may be connected.
PM 9864/01	Set point unit for one channel (inclusive slave potentiometer).
PM 9864/02	Set point unit for both channels in PM 8222.
PM 9865/01	Slave potentiometer, to be used in combination with one of the above remote control units.
PM 9866/01	Electrical pen lift to be used with remote control units PM 9862 or PM 9863.
PM 9867/01	Rack mounting brackets.
PM 9868/05	Eventmarker (right hand) to be used with remote control units PM 9862 or PM 9863.
PM 9868/10	Eventmarker (left hand) to be used with remote control units PM 9862 or PM 9863.
PM 9870M/04 ... -/15	Single range units with spans from 10 mV to 50 V in a 1, 2, 5 sequence.
PM 9872/02	Multirange unit with 12 calibrated spans from 10 mV to 50 V (1-2-5 sequence). Zero-suppression in 6 calibrated steps from 0% to 500% and continuously adjustable from +20% to −120% in every position.
PM 9872A/01	Multirange unit with 12 calibrated spans from 1 mV to 5 V (1-2-5 sequence). Zero-suppression in 6 calibrated steps from 0% to 500% and continuously adjustable from +20% to −120% in every position.
PM 9873/01	Temperature linearisation amplifier for thermocouples Fe-Co type J (−200° to +750 °C).
PM 9874/01	Temperature linearisation amplifier for thermocouples Ni Cr-Ni Al type K (−200° to 1200 °C).

Fig. 13 shows all the possible combinations of the available (and above mentioned) options, which can be fitted into the recorder. The components are represented by rectangles, which are interconnected by horizontal and vertical lines. The latter have to be followed from the top downwards only. On the intersections a choice has to be made. The upper part of the survey concerns the basic components, the lower part the optional components. The latter form an extension of the possibilities of the basic instrument (see chapter 2).

6.2. DETAILED TYPE INFORMATION

6.2.1. PM 9860, dust cover (fig. 14 and 15)

Insert the fixing lugs into holes and hook them around the spindles inside the recorder.

6.2.2. PM 9861, PM 9862 and PM 9863, remote control units

Figures 17, 18 and 19 refer to the connectors of the units PM 9861, PM 9862 and PM 9863 resp.
From the figures appear which functions can be remotely controlled and how the soldering connections have to be made. Remote control is effected either by applying logic levels or by contact closure only.
The table in fig. 19, shows the relationship between the position of the speed selector and the max. allowable frequency which may be applied. Speeds greater than 100 cm/min are not possible.
The units are fitted at the rear of the recorder and the external wiring must be plugged into the socket connector of the relevant unit. There the wiring has to be soldered onto the tags of the pin connector, supplied with each unit. Fig. 16 shows the rear of a dual pen recorder, provided with a unit PM 9862 and a setpoint unit PM 9864/02. Beside the PM 9862 a unit PM 9861 can be mounted and instead of a PM 9862 a unit PM 9863 can be fitted.

6.2.3. PM 9864/01 and -/02, setpoint unit for one and for two channels resp. (fig. 16, 20 and 21)

- Description
  The units provide an alarm signal on one and on two channels respectively when the scale indication exceeds a pre-set minimum ("MIN") and a pre-set maximum ("MAX") value.
  Signalling takes place within 1 mm of the adjusted value on the scale.

- Connections
  To the connectors of the -/01 and -/02 one and two alarm circuits resp. (e.g. lamp with power source) can be connected.

- Adjustment
  Move the pointer (of the relevant channel) with potentiometer "ZERO-VAR" to the required minimum scale indication and then adjust potentiometer "MIN" so that an alarm is obtained. Proceed in the same way to obtain "MAX" alarm indication.

REMARK

It is indicated on the unit to which channel the "MIN" and "MAX" potentiometers correspond; A and B refer to the upper and lower channel resp.

6.2.4. PM 9865/01, slave potentiometer

- Description
  From the slave potentiometer a voltage can be taken off, which is proportional to the scale indication.

- Connections
  The slave potentiometer is used in combination with one of the remote control units PM 9861, PM 9862 or PM 9863. Therefore refer to figures 17, 18 or 19.

6.2.5. PM 9866/01, electrical pen lift (fig. 22)

With switch R control is effected via remote control unit PM 9862 or PM 9863.
The connection data to the before mentioned units are shown in fig. 18 and 19.

6.2.6. PM 9867/01, rack mounting brackets (fig. 23, 24)

- After having removed the carrying handle the rack mounting brackets can be fitted (fig. 23).
- If required remove the four rubber feet by loosening the fixing screws.
- The dimensions of the hole for panel mounting of the recorder are given in fig. 24.

6.2.7. PM 9868/05 and -/10, right hand - and left hand event markers respectively (fig. 25, 26 and 27)

REMARKS

- *On delivery the event markers are not fitted on the chart table, they are seperately packed.*
- *They have to be used in combination with a remote control unit PM 9862 or PM 9863.*

Mounting and adjusting
The figures show how to fit an event marker to the chart table. The connection cable is fed through the square hole to the connector marked L and R (L and R stand for left-hand and right-hand respectively).

- Slide a writing pen onto the pen holder; turn the writing pen into the position, so that the recorded line is at approx. 1 mm distance from the sprocket holes (remove protection cap from writing pen).
- When the event marker is energised (see fig. 18 and/or 19) a deviation of 1 mm to the right is obtained.
- Adjusting to the correct time marking on the chart is possible by moving the pen holder forward or backward (first loosen fixing screw of the pen holder).

6.2.8. PM 9873/01 and PM 9874/01, temperature linearisation amplifiers

- Description

. Automatic cold junction compensation, fig. 28.
The voltage of the hot junction minus the voltage of the cold junction (U_{Th})- U_{Tc}) appears at the terminal X. The voltage $-U_{Tc}$ is compensated by the same value, opposite of sign ($+U_{Tc}$), which is induced by a constant current I through resistor R.
The latter is a temperature dependent resistor and has a value of R ohms at 0 °C and R ± ΔR at any other cold junction temperature. The values of I and R + ΔR are chosen in such a way that $IR + I\Delta R = U_R + U_{Tc}$.
The positive input of the amplifier is now $U_{Th} - U_{Tc} + U_R + U_{Tc} = U_{Th} + U_R$. The constant voltage U_R is compensated by means of a constant voltage U_A, applied to the negative input of the amplifier.
The output voltage of the amplifier is now exactly U_{Th} times the gain A. The automatic compensation can be made inoperative by interrupting the connections X8 to X15 and by interconnecting X15, X16 and X17.

Linearisation principle, fig. 29.
As described above the voltage, generated by the cold junction is compensated so that the true thermocouple voltage remains. The non-linearity of the latter is linearised now by automatic adjustment of the amplification. From fig. 29 it can be seen that the whole temperature range is split into seven areas and with the aid of level sensitive amplifiers, the required amplification is automatically obtained.

- Connections (fig. 3)

. The thermocouple must be connected to terminals "Hi" and "Lo", the screening of the connection cable to "⏚" terminal.

. The output of the temperature range unit is connected to the input terminals of the recorder with the cable supplied.

- Scale readings

As 1 mV corresponds to 1 degree C. the reading on the scale (chart) is directly in degrees C.
Range and zero suppression can be selected as has been described in chapter 5.6.

– Specifications

. Available types

Types	Thermocouple	Max. span
PM 9873/01	Fe-Co type J	–200 to +750 °C
PM 9874/01	NiCr - NiAl type K	–200 to +1200 °C
With automatic cold junction compensation (external compensation is possible.)		

. Temperature stability : $< \pm 0.06$ °C/°C

. Non-linearity : $< \pm 1$ °C in relation to IPTS68

. Output : 1 mV/°C, short circuit protected,can be used in all versions of the recorder types PM 8202 and PM 8222

. Supply voltage : 2x15 V from recorder transformer (current consumption 20 mA)

. Safety voltage : Maximum voltage between measuring system and earth
42 Vrms or 60 V DC
Test voltage 500 V DC

. Stray voltage rejection for recorder with linearisation amplifier (1 kΩ between Hi and Lo) : AC (50 Hz and higher)
CMRR $>$ 116 dB
SMRR $>$ 55 dB
DC CMRR $>$ 126 dB

. Recommended warming up time : 1 hour

7. MAINTENANCE AND FAULT FINDING

7.1. MAINTENANCE

As the manufacturing methods and the quality of the components are carefully selected, the maintenance can be reduced to a minimum. It is recommended to perform the jobs below once in every six months unless the recorder is used under particularly unfavourable circumstances; in this case shorter intervals may be desirable.

- The measuring potentiometer (fig. 30)
  ATTENTION: Do not use alcohol or any other liquid. Clean both tracks of the potentiometer fig. 30 with a dry clean brush (in the service box) and then apply a thin layer of contact oil to both tracks with the aid of the small brush supplied. The potentiometer is accessible after having removed the top cover.

- Clean the guide shaft with a dustfree cloth; do not lubricate.

7.2. FAULT FINDING

Certain simple troubles may be located and repaired with the aid of the list below.

Symptoms	Possible cause	Remedy
The recorder does not function and lamp "POWER ON" does not light.	Fuse defective. Mains cable defective. Lamp defective	Check fuse and mains cable and replace if necessary.
Measuring system oscillates.	Wrong earthing of the input circuit.	Check earthing of the input circuit and modify if necessary (see chapter 4.3.).
Irregular movement of the measuring system.	Dirty measuring potentiometer.	Clean measuring potentiometer.
Chart feed does not function.	Chart table incorrectly fitted in the recorder.	Fit the chart table in the correct position.
Chart runs askew.	Chart is not correctly positioned on the transport roller.	Reposition chart in the chart table.
Writing system does not function properly.	Pen worn out or cartridge is empty.	Replace the pen cartridge.

8. TECHNICAL SPECIFICATIONS

GENERAL

This instrument has been designed and tested according to IEC Publication 348 and VDE 411 for Class I instruments and has been supplied in a safe condition. The present Operating Manual contains instructions and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

Properties expressed in numerical values with stated tolerances guaranteed for ambient temperatures of +5 °C ... +40 °C unless stated otherwise.
Numerical values without tolerances are typical and represents the characteristics of an average instrument.

8.1. PERFORMANCE SPECIFICATIONS

8.1.1. Input ranges (range units)

- Single range units type PM 9870M/. . from 10 mV onwards to 50 V and with a continuously adjustable zero suppression along the scale (from +20 % to −120 %).
- Multirange units type PM 9872/02 from 10 mV to 50 V in calibrated steps (1-2-5 sequence) and with (overlapping) variable span adjustment. Zero suppression continuously adjustable (along the scale) and in 5 calibrated steps up to 500 %.
- Multirange units type PM 9872A/01 from 1 mV to 5 V in calibrated steps (1-2-5 sequence) and with (overlapping) variable span adjustment. Zero suppression continuously adjustable (along the scale) and in 5 calibrated steps up to 500 %.

8.1.2. Accuracy

- For recorders PM 8202 - PM 8222 versions /01 and /21
  from 10 mV to 500 mV incl. ± 0.3 % fsd ± 0.2 % of reading
  from 1 V to 50 V ± 0.3 % fsd ± 0.4 % of reading
  (zero point drift ⩽ 8.25 μV/K)
- For recorders PM 8202 - PM 8222 version /32
  from 1 mV - 50 mV incl. ± 0.3% fsd ± 0.2% of reading
  from 100 mV - 5 V ± 0.3% fsd ± 0.4% of reading
  (zero point drift ⩽ 0.25 μV/K)

NOTES:

- *The accuracy is inclusive non-linearity and dead band (⩽ 0.5 mm).*
- *The stepwise calibrated zero suppression selection has an accuracy of 0.4% /step.*
- *Switching from one range to another rannge may give a zero shift of 0.5 % f.s.d. maximum.*

8.1.3. Step response time

0.25 sec. for f.s.d.

8.1.4. Frequency response

- For recorders PM 8202 - PM 8222 versions /01 and /32
  minus 10% at 3.5 Hz for 66% f.s.d. (sine wave)
  minus 10% at 5 Hz for 10% f.s.d. (sine wave)
- For recorders PM 8202 - PM 8222 version /21
  minus 10% at 2 Hz for 66% f.s.d. (sine wave)
  minus 10% at 2 Hz for 10% f.s.d. (sine wave)

8.1.5. Input

– Type	floating
– Impedance	1 MΩ ± 1 %
– Max. voltage between	
Hi and Lo	30 V ac or 60 V dc
Hi/Lo and earth	30 V ac or 60 V dc
– Insulation resistance	Hi/Lo – Earth ⩾ 2000 MΩ

8.1.6. Stray voltage rejection (1 kΩ between Hi and Lo)

Recorder version ⟶	/01	/21 and /32
AC CMRR	> 96 dB	> 116 dB
AC SMRR	> 32 dB	> 52 dB
DC CMRR	> 126 dB	> 126 dB

8.1.7. Source impedance

– Does not effect dynamic response.

8.1.8. Damping

– Overshoot ⩽ 1 %.

8.1.9. Chart transport

– 11 speeds: 0.05 - 0.1 - 0.2 - 0.5 - 1 - 2 - 5 - 10 - 20 - 50 - 100 cm/min
– Accuracy is determined by the mains frequency only
– Fast forward - stop - fast reverse
– Forward - stop
– Remote control facilities (see chapter 6)

8.1.10. Chart

– Z folded books
– Length 20 m
– Recording width 250 mm

8.1.11. Writing system

– Disposable nylon pen cartridges (see chapter 3.2)
– Effective recording length 1500 m approx.
– Pen distance 5 mm (for PM 8222)

8.1.12. Options

– See chapter 6.

8.2. GENERAL DATA

– Environmental conditions	According to IEC 359
– Climatic conditions	Group I with extension of the temperature limits. Ambient temperature : reference 23 °C ± 1 °C Rated range of use : +5 °C ... +40 °C Relative humidity : 20 % ... 80 % (Excluding condensation) reference 45 % ... 75 % Storage temperature : –40 °C ... +70 °C
– Mechanical conditions	Group M2 according to IEC 68
– Supply conditions	Group S2 according to IEC 359 Mains voltage 110, 127, 220, 245 V ± 10 % (Selectable at the rear of the instrument) Mains frequency 50/60 Hz ± 1.5 % Power consumption PM 8202 - 40 VA, PM 8222 - 80 VA
– Radio interference (conducted)	Class II according to CISPR 14 Class II, VDE 875 - Kgraph
– Safety	Class I according to IEC 348
– Warning up time	Approx. 30 min.
– Dimensions	Height : 132 mm Width : 445 mm Depth : 265 mm (without chart table)
– Weight	Approx. 10 kg

9. PRINCIPLE OF OPERATION

9.1. AUTOMATIC COMPENSATION (fig. 31)

The recorder is based on the principle of automatic compensation, as shown in fig. 31. If U_c is equal to U_i the input voltage of the amplifier is zero and as a consequence the output voltage is zero. If the input voltage changes, a voltage difference appears at the amplifier input so that the output voltage now controls the servomotor M. The servomotor, coupled to the slider of the measuring potentiometer Rm via a card transmission, starts running until U_i is equal to U_c again.

9.2 BLOCK DIAGRAM (fig. 32 and 33)

Depending on its amplitude the input signal is amplified or attenuated to a 1V signal by means of the amplifier/attenuator. After having passed an interference suppression filter, the input signal U_i is compared to the voltage of the sliding contact of the measuring potentiometer U_c. The difference signal is amplified and then applied to the power amplifier. Depending on the polarity of the difference signal the servomotor rotates clockwise or anti clockwise. As the sliding contact is mechanically coupled to the servomotor the motor stops when the difference signal has become zero. The servomotor is also coupled to a generator which supplies a voltage which is proportional to the rotating speed of the motor. In this way a critically damped system is obtained. The servomotor is overload protected by a slip coupling and an overload protection circuit. If the measuring carriage hits the end stops (or is held by an external force) the corddrum on the servomotor shaft starts slipping and within two minutes the supply voltage for the motor is then lowered. In this way unnecessary wearing or damage is avoided. The recording chart is driven via a gear transmission by a stepping motor. The speed is determined by the frequency applied to the motor. The oscillator frequency of 300 Hz corresponds to the highest chart speed. By dividing the oscillator frequency lower speeds are obtained (SK1). By applying logic levels to the motor control circuit the chart can be driven in forward or in reverse direction (SK2). Fast transport is obtained by letting slowly increase the oscillator frequency from 30 to 500 Hz.

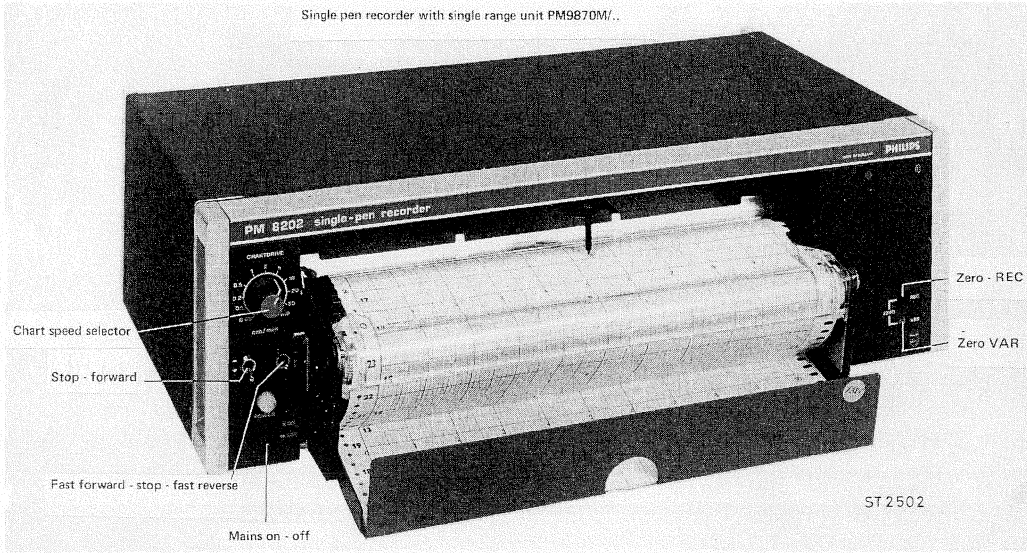


Fig. 1.

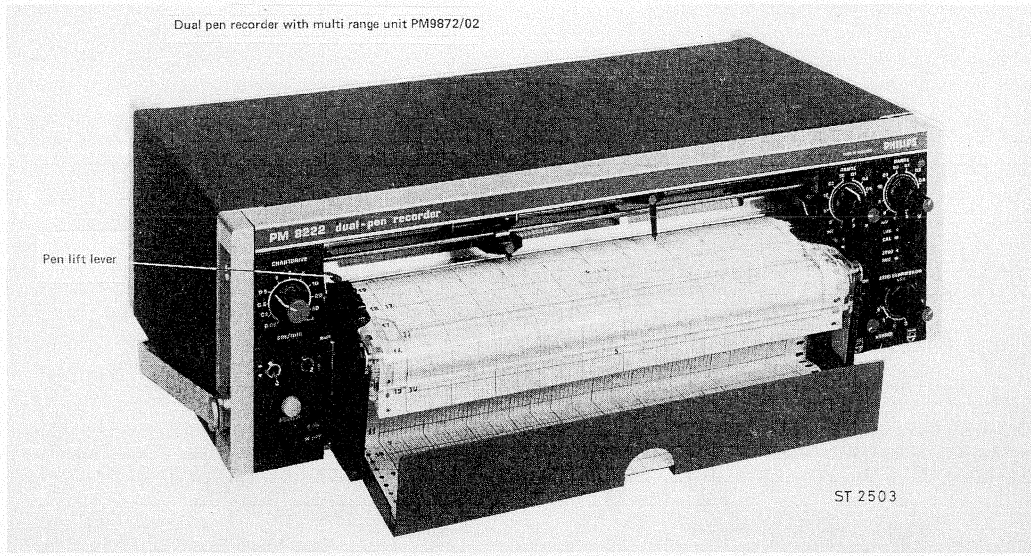


Fig. 2a.

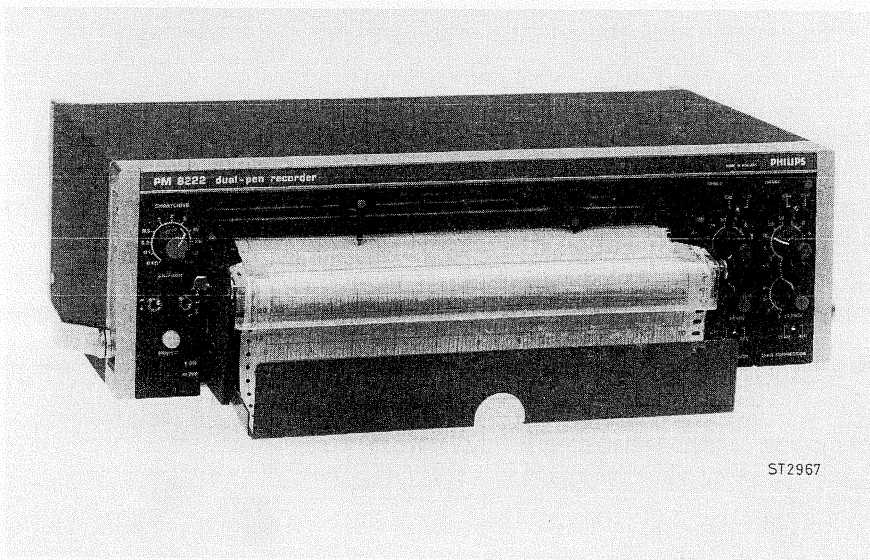


Fig. 2b. Recorder met PM 9872A/01

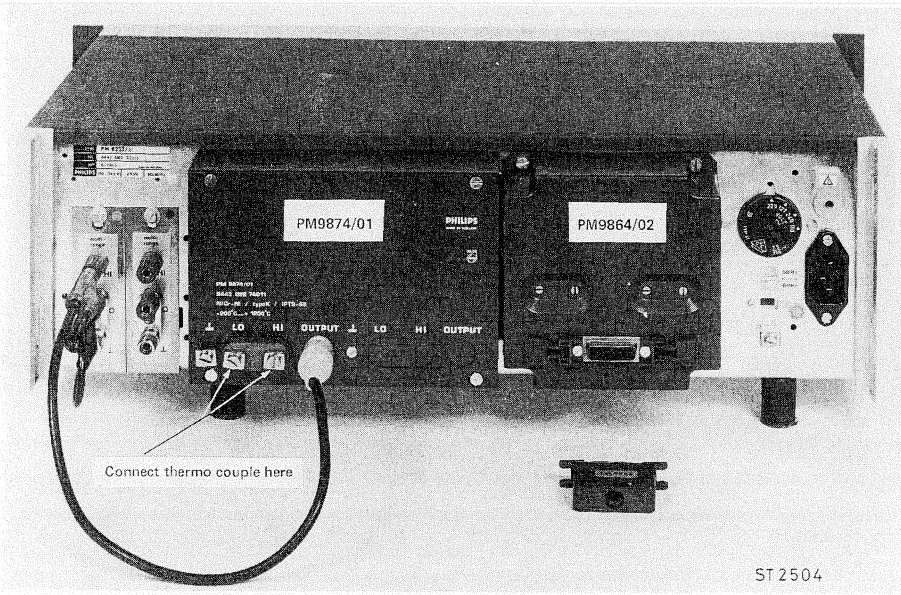


Fig. 3.

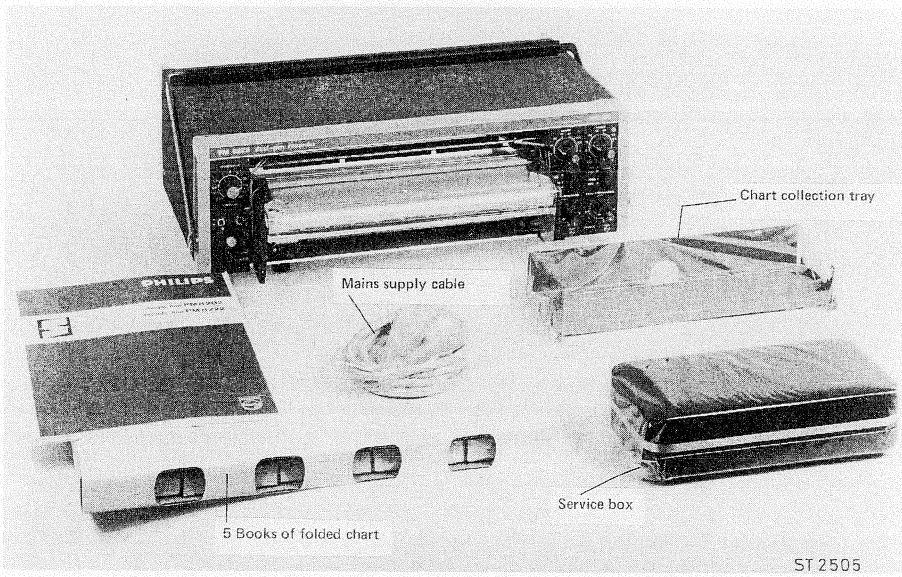


Fig. 4.

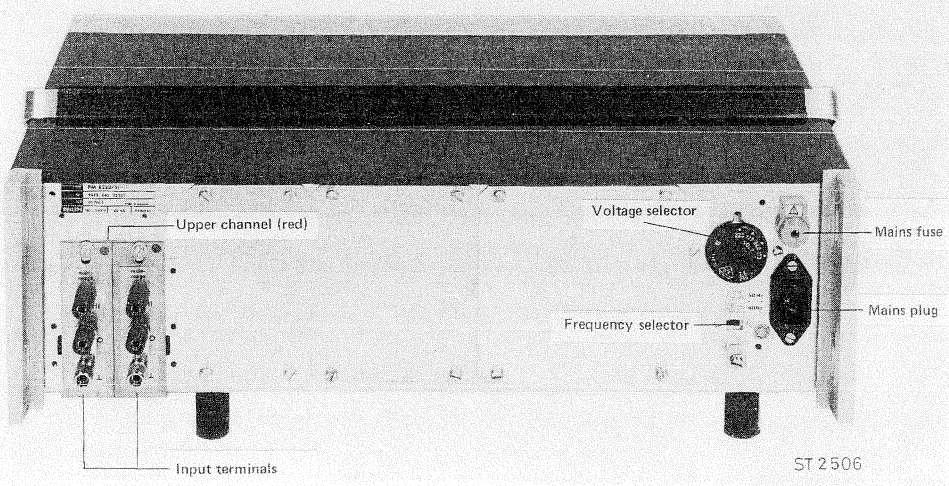


Fig. 5.

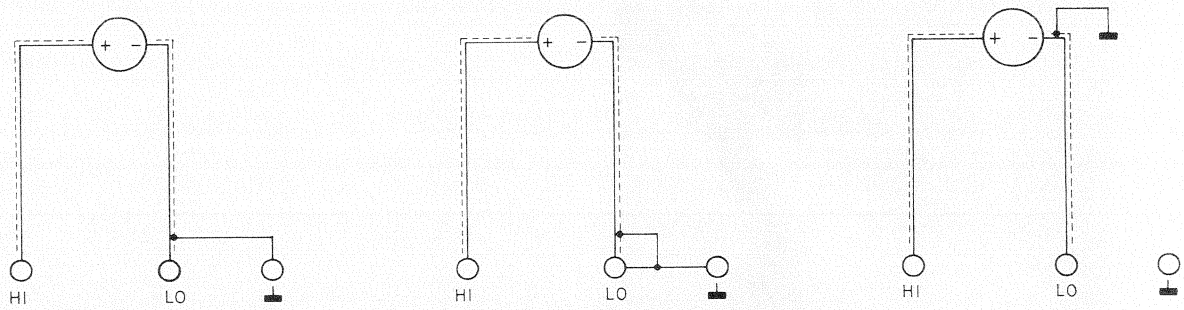


Fig. 6.

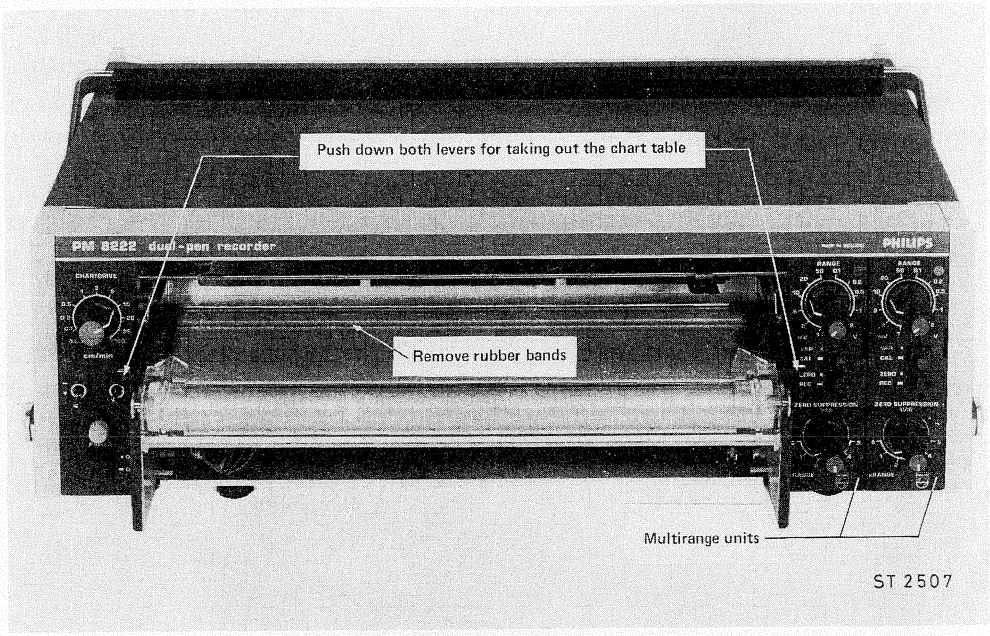


Fig. 7.

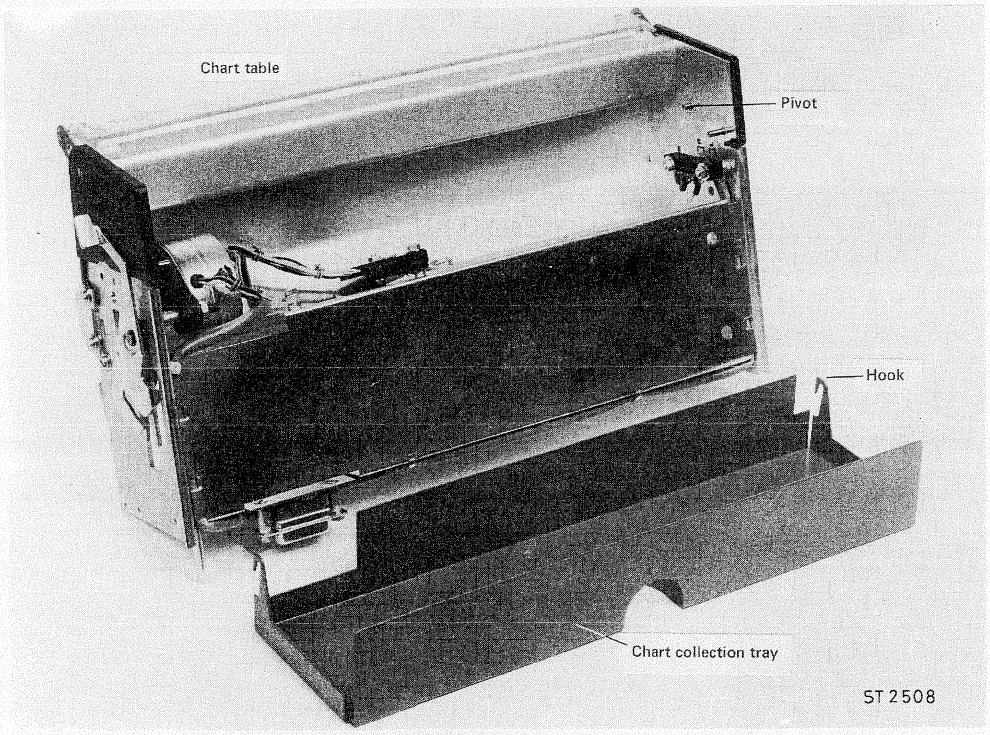


Fig. 8.

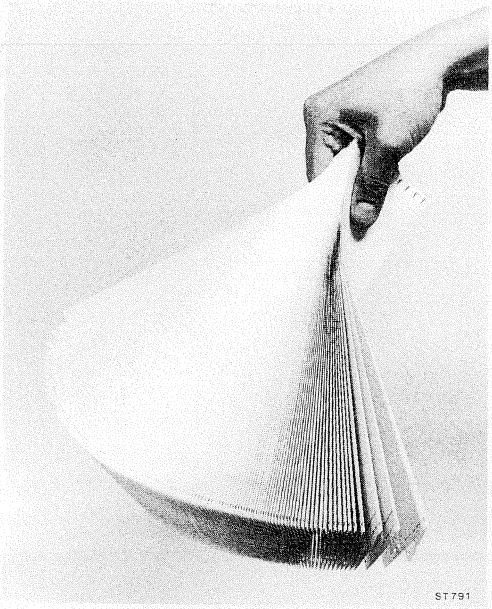


Fig. 9.

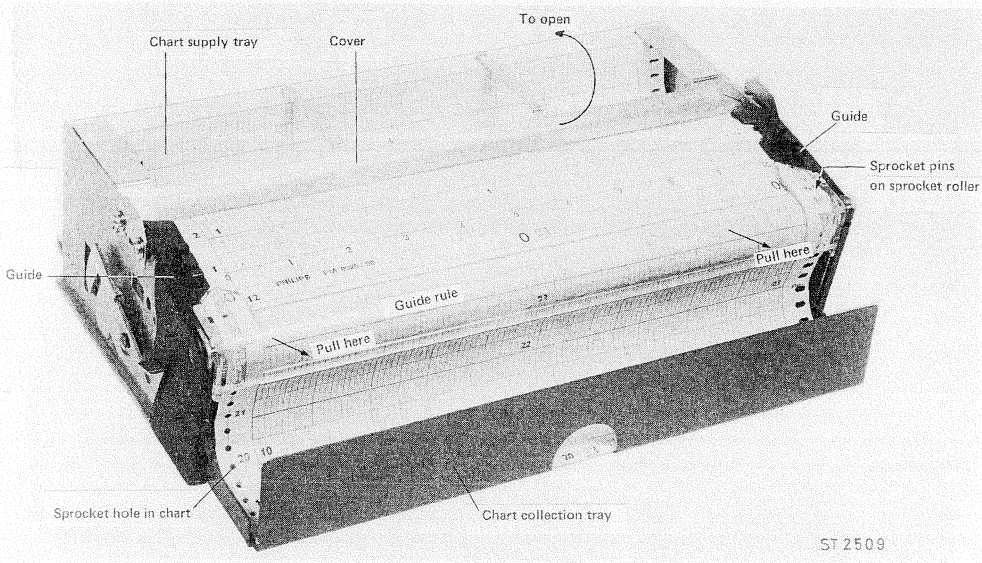


Fig. 10.

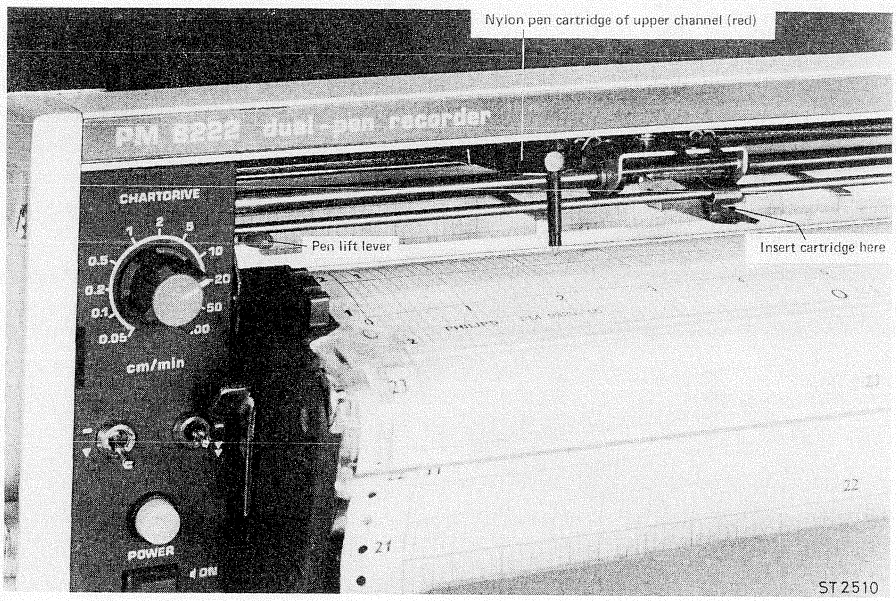


Fig. 11.

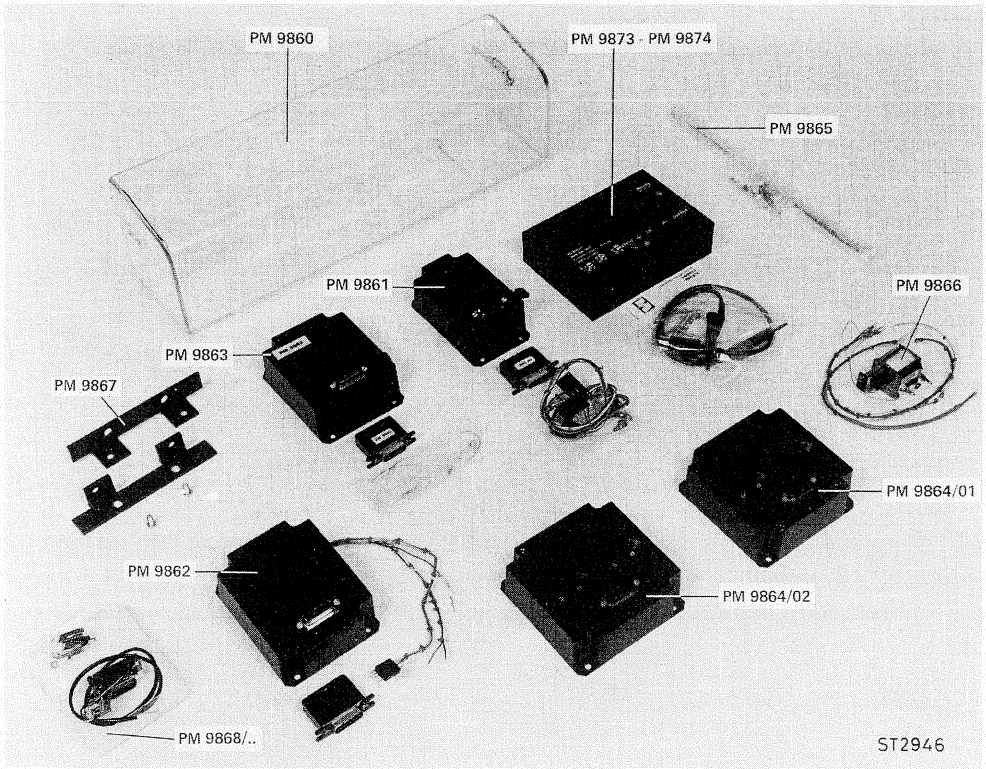

PM 9860
PM 9873 - PM 9874
PM 9865
PM 9861
PM 9866
PM 9863
PM 9867
PM 9864/01
PM 9862
PM 9864/02
PM 9868/..
ST2946

Fig. 12.

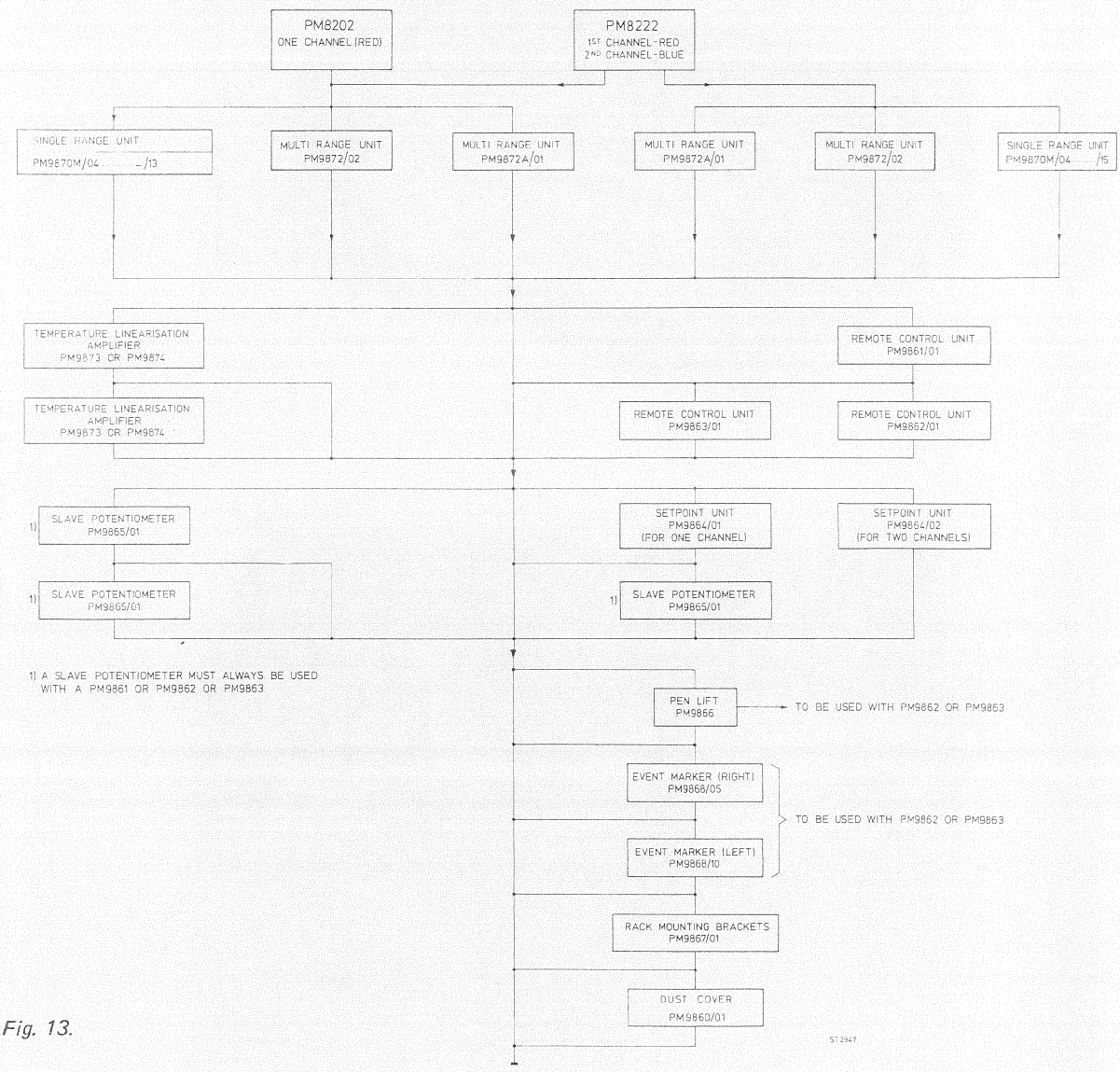

PM8202
ONE CHANNEL (RED)
PM8222
1ST CHANNEL-RED
2ND CHANNEL-BLUE
SINGLE RANGE UNIT
PM9870M/04 ... -/13
MULTI RANGE UNIT
PM9872/02
MULTI RANGE UNIT
PM9872A/01
MULTI RANGE UNIT
PM9872A/01
MULTI RANGE UNIT
PM9872/02
SINGLE RANGE UNIT
PM9870M/04 ... /15
TEMPERATURE LINEARISATION AMPLIFIER
PM9873 OR PM9874
TEMPERATURE LINEARISATION AMPLIFIER
PM9873 OR PM9874
REMOTE CONTROL UNIT
PM9861/01
REMOTE CONTROL UNIT
PM9863/01
REMOTE CONTROL UNIT
PM9862/01
1) SLAVE POTENTIOMETER
PM9865/01
1) SLAVE POTENTIOMETER
PM9865/01
SETPOINT UNIT
PM9864/01
(FOR ONE CHANNEL)
SETPOINT UNIT
PM9864/02
(FOR TWO CHANNELS)
1) SLAVE POTENTIOMETER
PM9865/01
1) A SLAVE POTENTIOMETER MUST ALWAYS BE USED WITH A PM9861 OR PM9862 OR PM9863
PEN LIFT
PM9866
TO BE USED WITH PM9862 OR PM9863
EVENT MARKER (RIGHT)
PM9868/05
EVENT MARKER (LEFT)
PM9868/10
TO BE USED WITH PM9862 OR PM9863
RACK MOUNTING BRACKETS
PM9867/01
DUST COVER
PM9860/01
ST2947

Fig. 13.

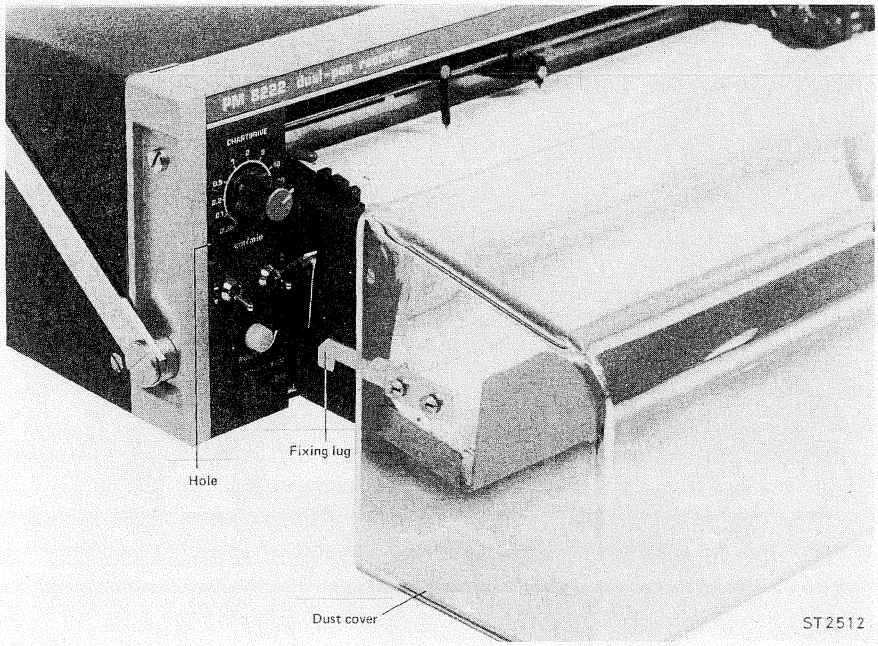


Fig. 14.

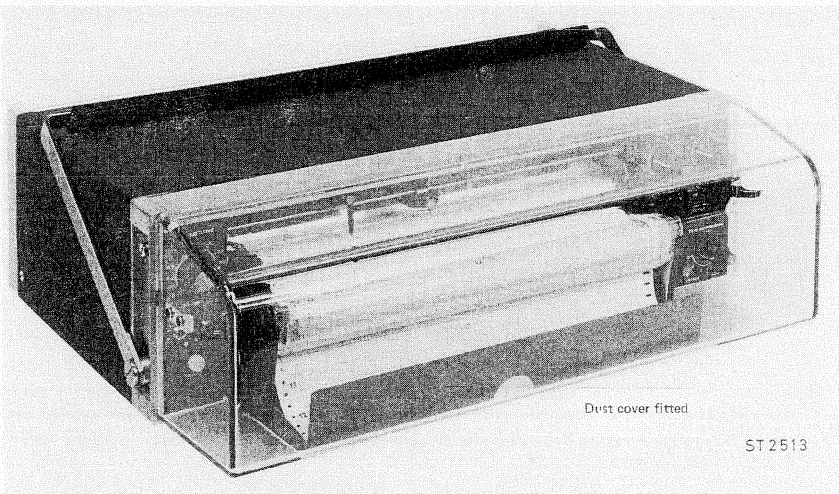


Fig. 15.

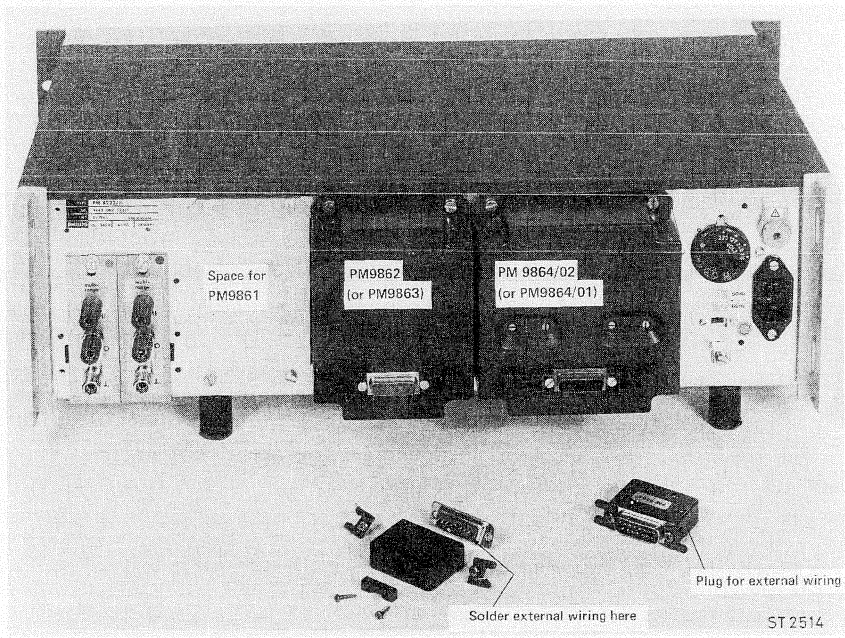
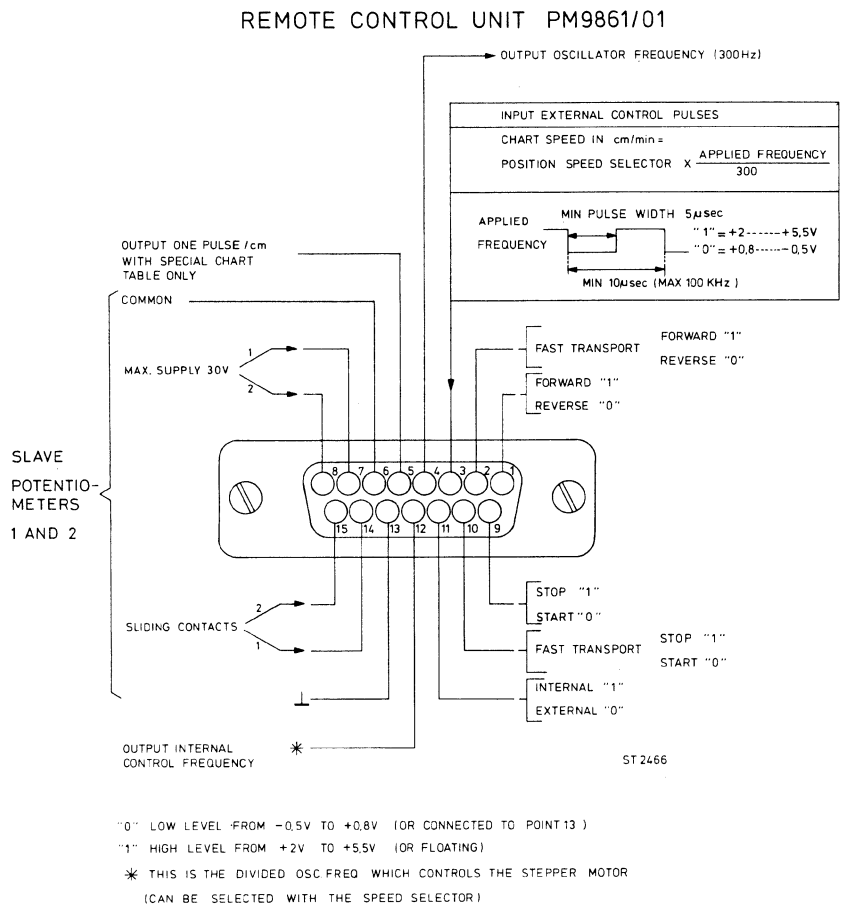
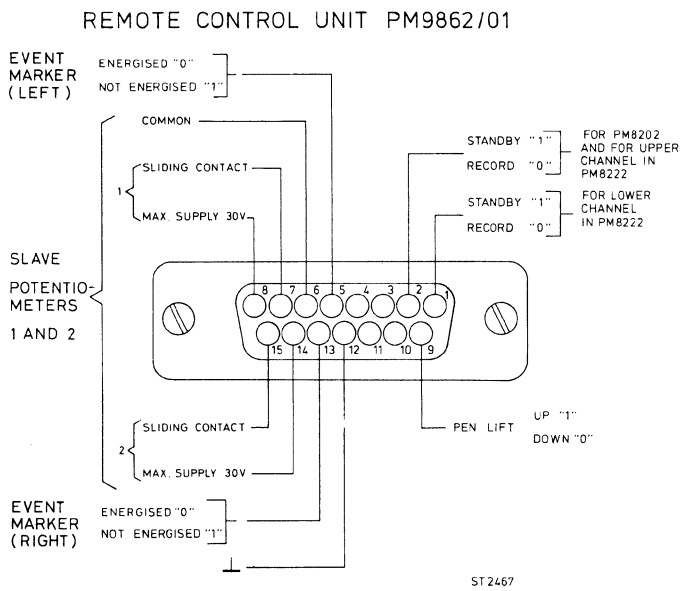


Fig. 16.



"0" LOW LEVEL FROM -0,5V TO +0,8V (OR CONNECTED TO POINT 13)
"1" HIGH LEVEL FROM +2V TO +5,5V (OR FLOATING)
✳ THIS IS THE DIVIDED OSC FREQ WHICH CONTROLS THE STEPPER MOTOR (CAN BE SELECTED WITH THE SPEED SELECTOR)

Fig. 17.



"0" LOW LEVEL FROM -0,5V TO +0,8V (OR CONNECTED TO POINT 12)
"1" HIGH LEVEL FROM +2V TO +5,5V (OR FLOATING)

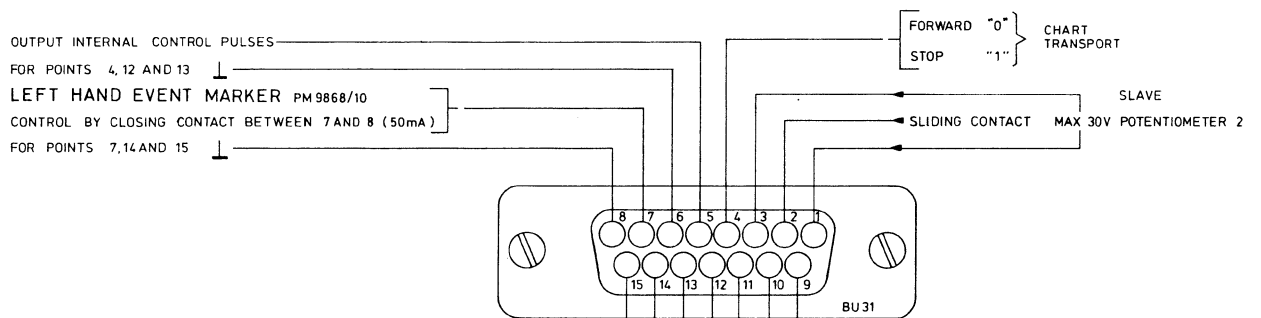
Fig. 18.

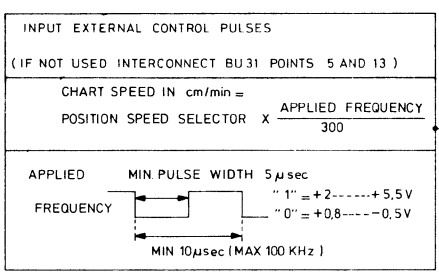
Fig. 19.

Position speed selector cm/min.	Dividing factor	Max. input frequency Hz.
100 (MAX. speed!)	1	300
50	2	600
20	5	1500
10	10	3000
5	20	6000
2	50	15 000
1	100	30 000
0.5	200	60 000
0.2	500	max. 100 Kc
0.1	1000	max. 100 Kc
0.05	2000	max. 100 Kc

MAX. INPUT FREQUENCY = DIVIDING FACTOR x 300 (MAX. 100kHz)

REMOTE CONTROL UNIT PM9863/01


OUTPUT INTERNAL CONTROL PULSES
FOR POINTS 4, 12 AND 13
LEFT HAND EVENT MARKER PM 9868/10
CONTROL BY CLOSING CONTACT BETWEEN 7 AND 8 (50mA)
FOR POINTS 7, 14 AND 15
FORWARD "0"
STOP "1"
CHART TRANSPORT
SLAVE
SLIDING CONTACT MAX 30V POTENTIOMETER 2
8 7 6 5 4 3 2 1
15 14 13 12 11 10 9
BU 31
SLAVE
SLIDING CONTACT MAX 30V POTENTIOMETER 1
PEN LIFT CONTROL BY CLOSING CONTACT
BETWEEN POINTS 15 AND 8 (500mA)
RIGHT HAND EVENT MARKER PM 9868/05
CONTROL BY CLOSING CONTACT BETWEEN 8 AND 14 (50mA)
INPUT EXTERNAL CONTROL PULSES
CHART TRANSPORT
REVERSE "0"
STOP "1"
"0" = +0,8V TO −0,5V OR CONNECTED TO POINTS 6 OR 8
"1" = +2V TO +5,5V OR NOT CONNECTED (LEFT OPEN)


INPUT EXTERNAL CONTROL PULSES
(IF NOT USED INTERCONNECT BU 31 POINTS 5 AND 13)
CHART SPEED IN cm/min =
POSITION SPEED SELECTOR X APPLIED FREQUENCY / 300
APPLIED FREQUENCY
MIN PULSE WIDTH 5 µsec
"1" = +2 ------ +5,5 V
"0" = +0,8 ----- −0,5 V
MIN 10µsec (MAX 100 KHz)

ST 2523

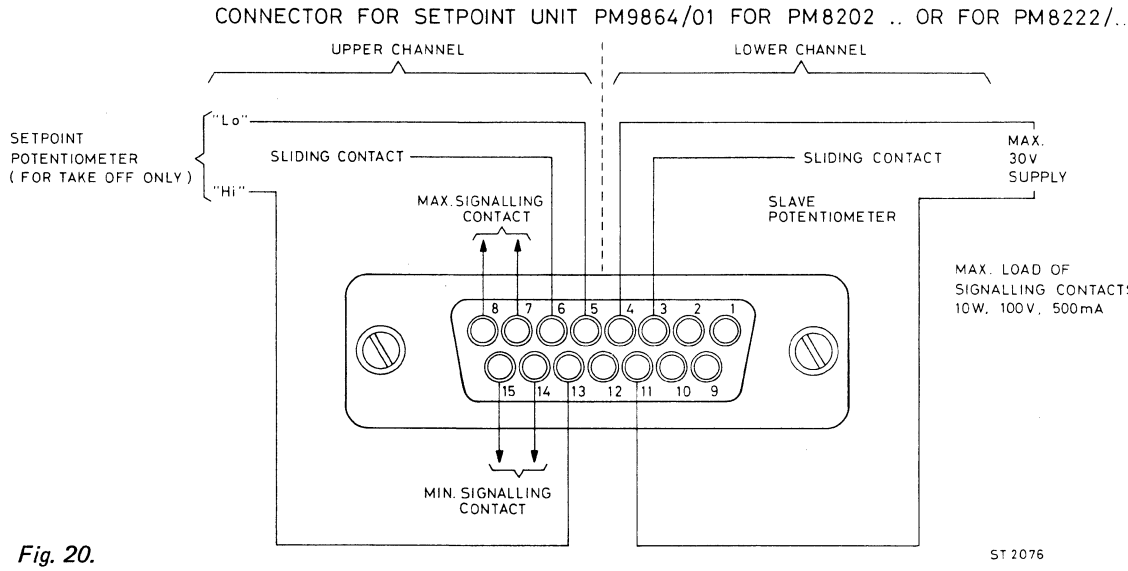

CONNECTOR FOR SETPOINT UNIT PM9864/01 FOR PM8202 .. OR FOR PM8222/..
UPPER CHANNEL
LOWER CHANNEL
SETPOINT POTENTIOMETER (FOR TAKE OFF ONLY)
"Lo"
"Hi"
SLIDING CONTACT
SLIDING CONTACT
MAX. 30V SUPPLY
MAX. SIGNALLING CONTACT
SLAVE POTENTIOMETER
MAX. LOAD OF SIGNALLING CONTACTS 10W, 100V, 500mA
8 7 6 5 4 3 2 1
15 14 13 12 11 10 9
MIN. SIGNALLING CONTACT
ST 2076

Fig. 20.

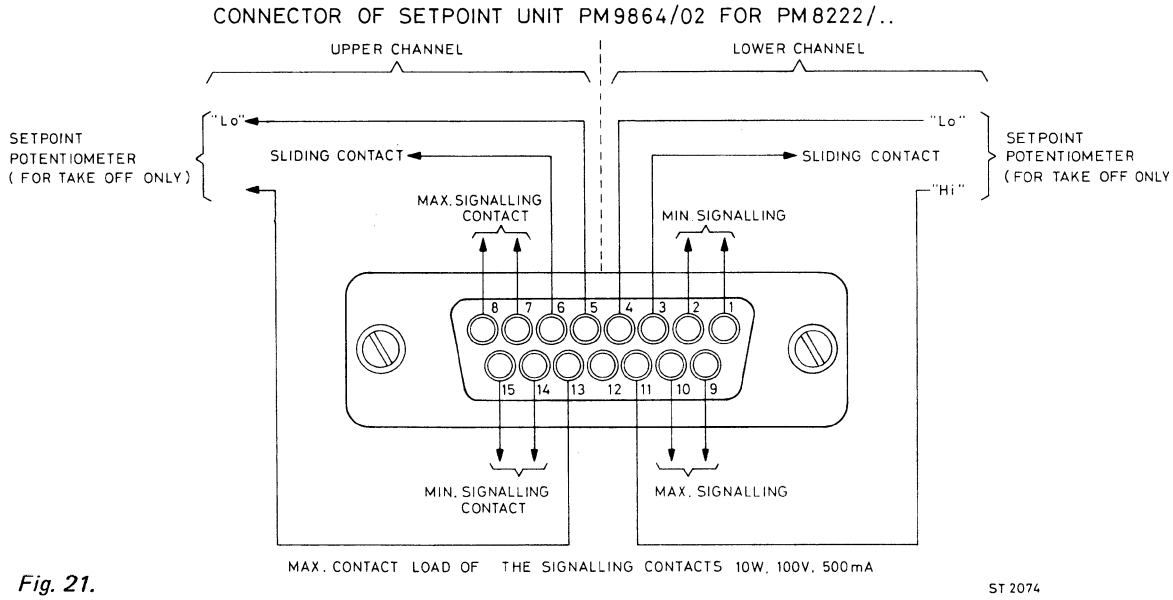

CONNECTOR OF SETPOINT UNIT PM9864/02 FOR PM8222/..
UPPER CHANNEL
LOWER CHANNEL
SETPOINT POTENTIOMETER (FOR TAKE OFF ONLY)
"Lo"
SLIDING CONTACT
"Lo"
SLIDING CONTACT
SETPOINT POTENTIOMETER (FOR TAKE OFF ONLY)
"Hi"
MAX. SIGNALLING CONTACT
MIN. SIGNALLING
8 7 6 5 4 3 2 1
15 14 13 12 11 10 9
MIN. SIGNALLING CONTACT
MAX. SIGNALLING
MAX. CONTACT LOAD OF THE SIGNALLING CONTACTS 10W, 100V, 500mA
ST 2074

Fig. 21.

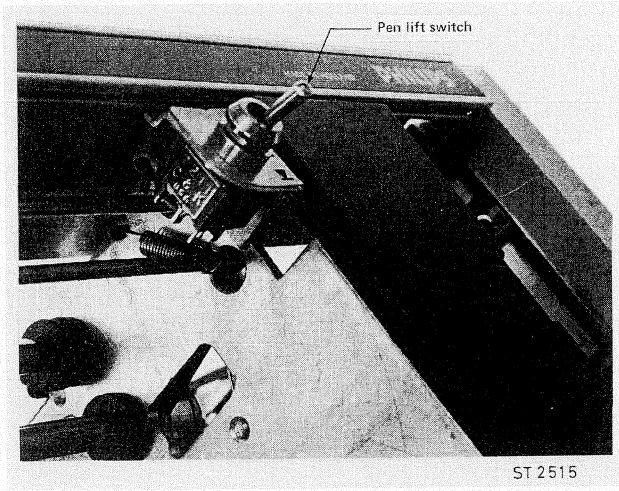


Fig. 22.

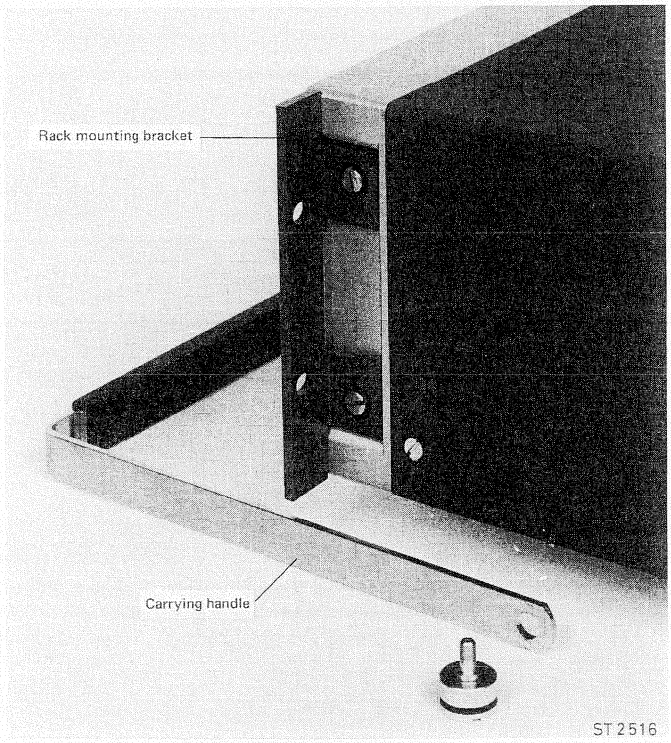


Fig. 23.

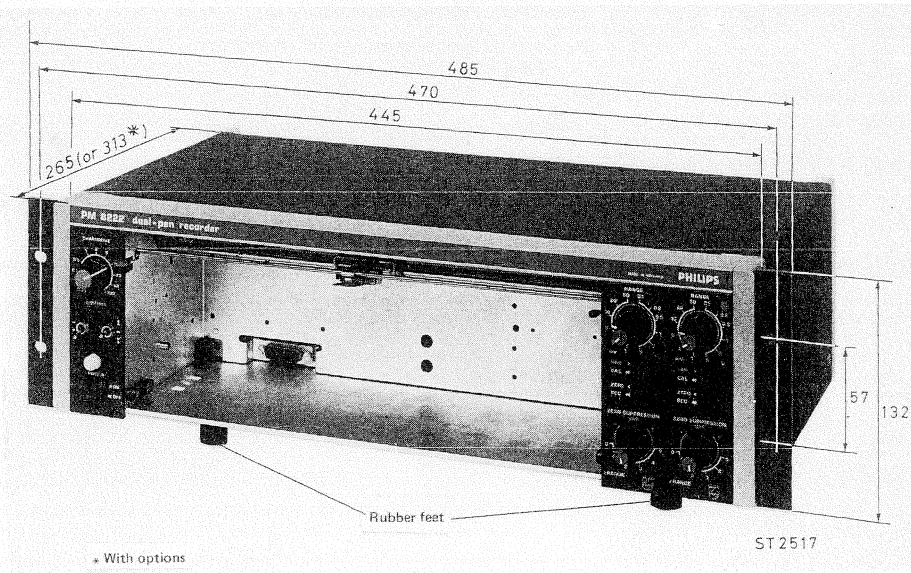


Fig. 24.

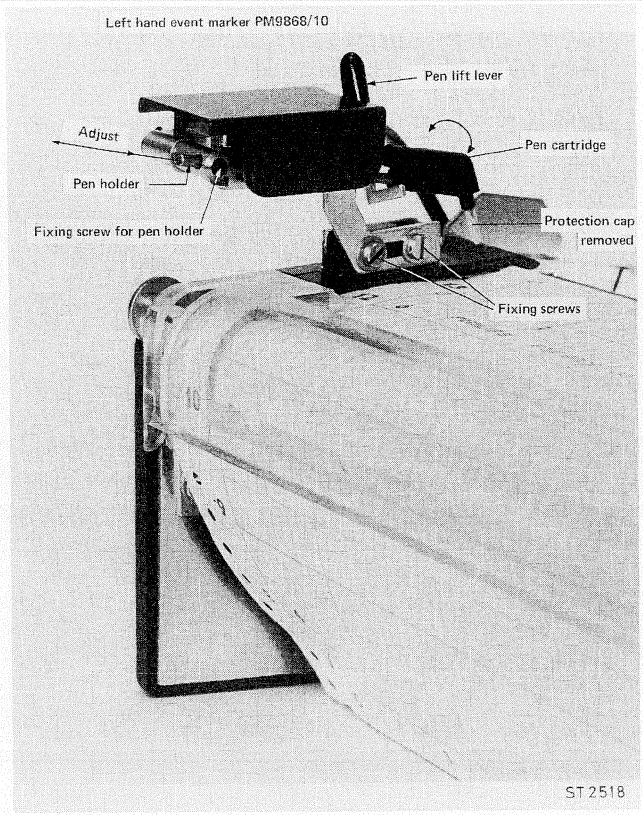

Left hand event marker PM9868/10
Pen lift lever
Adjust
Pen cartridge
Pen holder
Protection cap
removed
Fixing screw for pen holder
Fixing screws
ST 2518

Fig. 25.

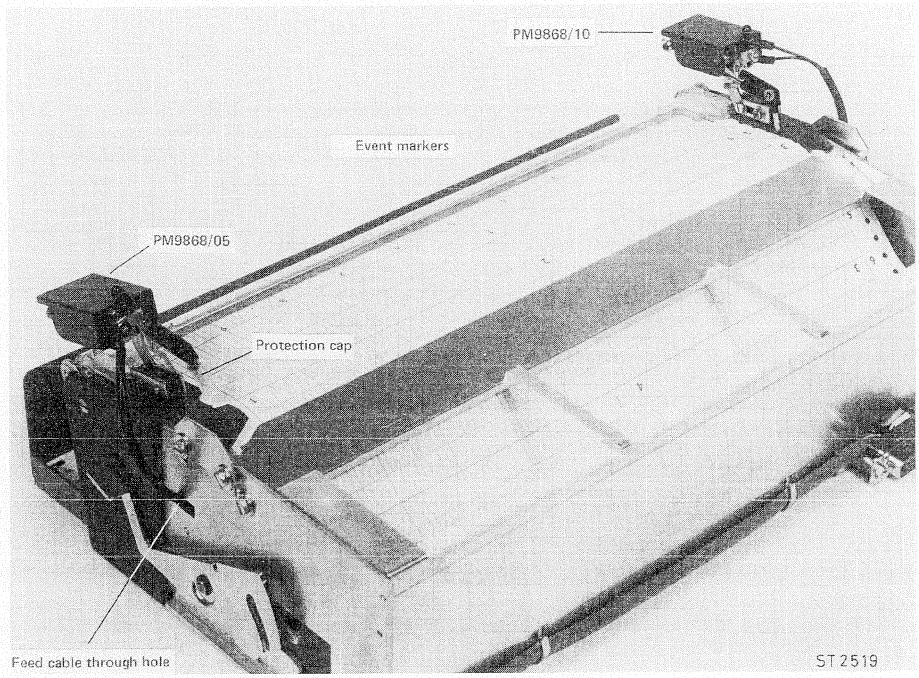

PM9868/10
Event markers
PM9868/05
Protection cap
Feed cable through hole
ST 2519

Fig. 26.

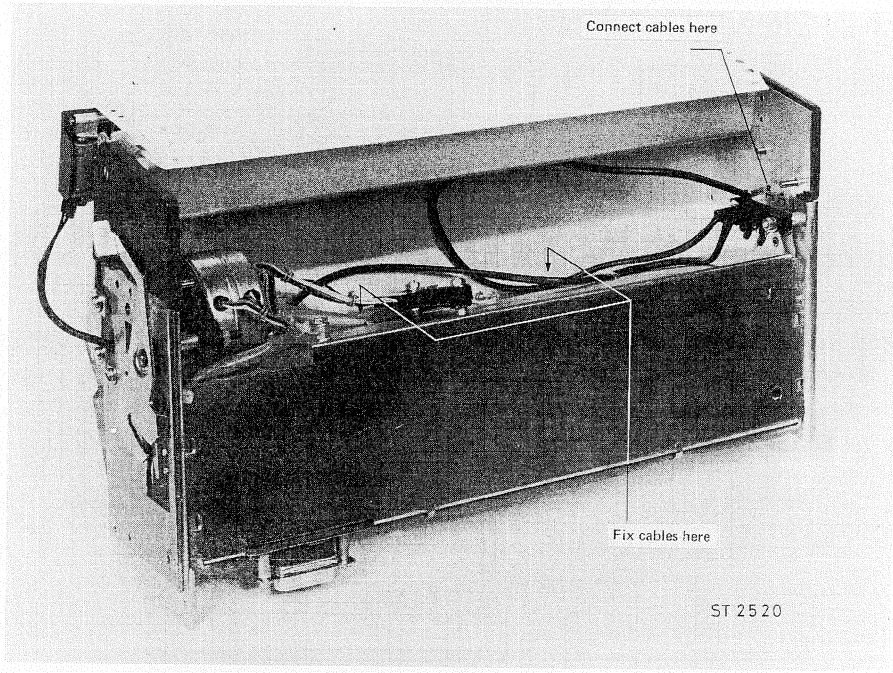

Connect cables here
Fix cables here
ST 2520

Fig. 27.

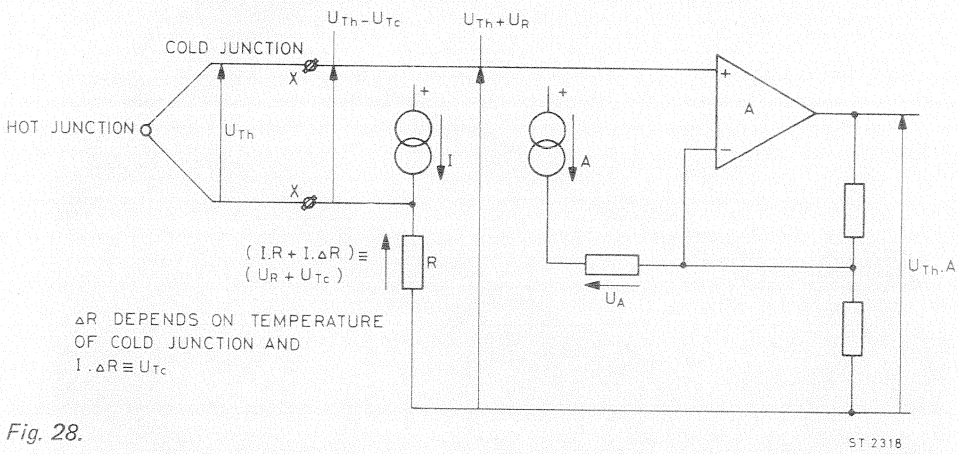

$U_{Th}-U_{Tc}$
$U_{Th}+U_R$
COLD JUNCTION
X
HOT JUNCTION
U_{Th}
X
+
I
+
A
+
A
−
$(I.R + I.\Delta R) \equiv$
$(U_R + U_{Tc})$
R
U_A
$U_{Th}.A$
ΔR DEPENDS ON TEMPERATURE
OF COLD JUNCTION AND
$I.\Delta R \equiv U_{Tc}$
ST 2318

Fig. 28.

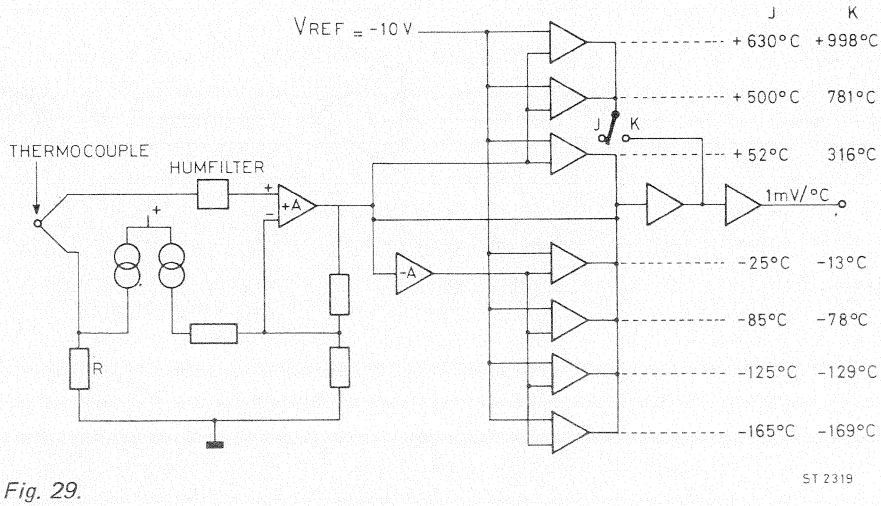

VREF = -10 V
J
K
+630°C
+998°C
+500°C
781°C
J
K
+52°C
316°C
THERMOCOUPLE
HUMFILTER
+A
1mV/°C
-A
-25°C
-13°C
-85°C
-78°C
-125°C
-129°C
-165°C
-169°C
R
ST 2319

Fig. 29.

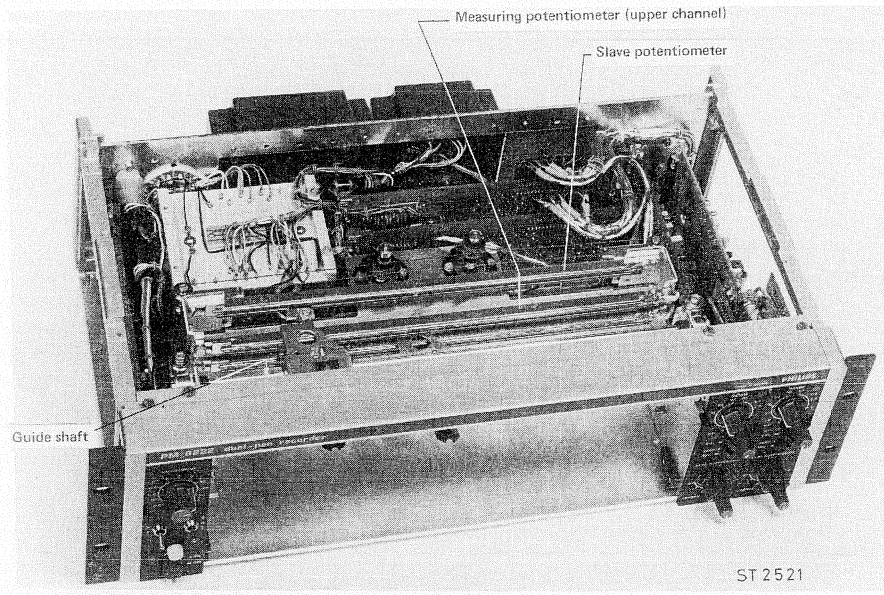

Measuring potentiometer (upper channel)
Slave potentiometer
Guide shaft
ST 2521

Fig. 30.

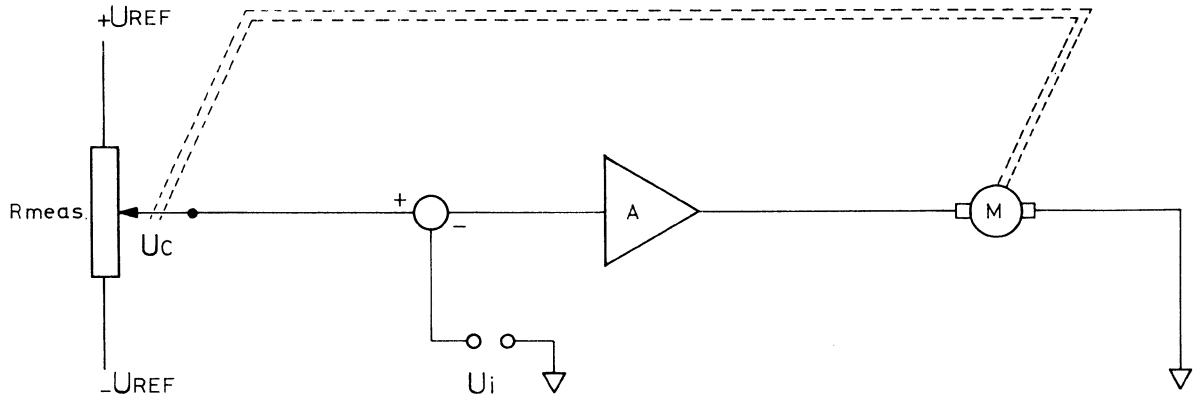


Fig. 31.

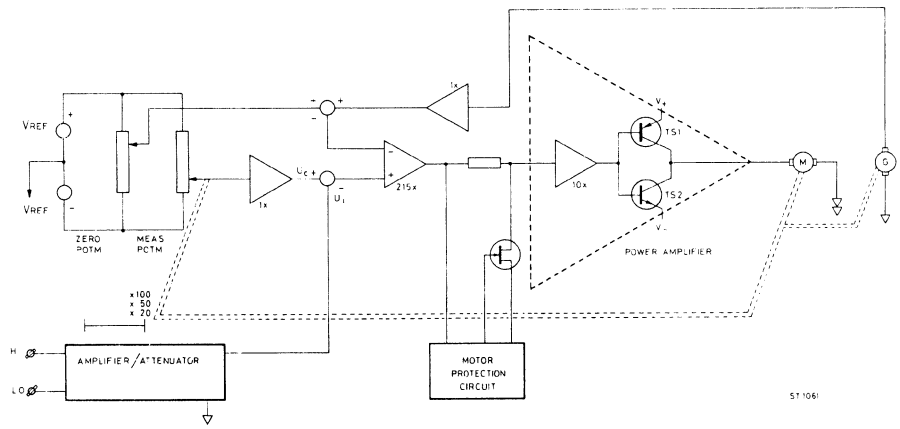


Fig. 32.

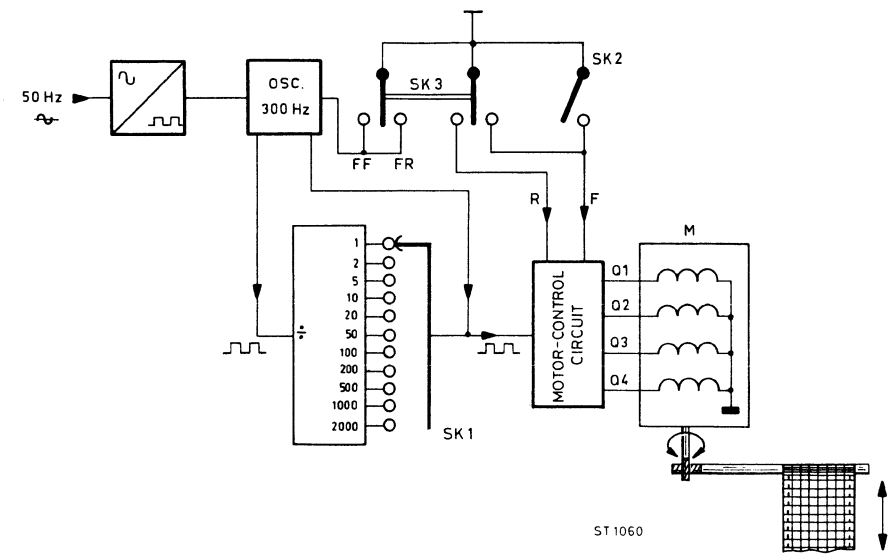


Fig. 33.